16.35

Aerospace Software Engineering

Ada 95 – “some basics”

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Ada …

- Cost study done in 1973-1974 determined that the US Department of Defense was spending $3 billion annually on software
- Evaluated 23 existing languages against the "Tinman" requirements:
  - FORTRAN, COBOL, PL/I, HAL/S, TACPOL, CMS-2, CS-4, SPL/I, JOVIAL J3, JOVIAL J73, ALGOL 60, ALGOL 68, CORAL 66, Pascal, SUMULA 67, LIS, LTR, TRL/2, EUCLID, PDL2, PEARL, MORAL, EL/I
- Augusta Ada Byron (1815-1852), Countess of Lovelace

A Small Ada Program - Mini

```
-- What is program supposed to be doing? Inputs/outputs?
-- Author(s):
-- Last updated:
-- Comments:

with Ada.Text_Io;

procedure Mini is
   -- declarations
   K    : constant Integer := 5;
   X, Y : Integer;

begin
   -- executable code
   Ada.Text_Io.Put (Item => ”Hello world!”);
   X := 10;
   Y := X * K; -- calculations
   Y := X + 1;
end Mini;
```

Reserved Words

- These identifiers are reserved for special significance in the language
- A *reserved word* must not be used as a declared identifier

```
abort     else      new       select
abs       elsif     not       separate
abstract  end       null      subtype
accept    entry
access    exception of        tagged
aliased   exit      or        task
all               others    terminate
and       for       out       then
array     function            type
at                  package
          generic   pragma    until
begin     goto      private   use
body                procedure
          if        protected when
case      in                  while
constant  is        raise     with
                    range
declare   limited   record    xor
delay     loop      rem
delta               renames
digits    mod       requeue
do                  return
                    reverse
```

Finding the Value of a Coin Collection

- Problem Specification
  - Your little sister has been saving nickels and pennies for quite a while. Because she is getting tired of lugging her piggy bank with her whenever she goes to the store, she would like to trade in her collection for one-dollar banknotes and some change. To do this, she would like to know the value of her coin collection in dollars and cents.
- Analysis
  - To solve this problem, we must be given the count of nickels and pennies in the collection. The first step is to determine the total value of the collection in cents. Once we have this figure, we can do an integer division using 100 as the divisor to get the dollar value; the remainder of this division will be the loose change that she should receive. In the data requirements below, we list the total value in cents (`TotalCents`) as a program variable because it is needed as part of the computation process; it is not a required problem output.

Finding the Value of a Coin Collection

- Data Requirements and Formulas
  - Problem Inputs:
    `Nickels` : Natural (the number of nickels)
    `Pennies` : Natural (the number of pennies)
  - Problem Outputs:
    `Dollars` : Integer (the number of $s she should receive)
    `Change` : Integer (the loose change she should receive)
  - Additional Program Variables:
    `TotalCents` : Integer (the total number of cents)
  - Relevant Formulas
    One nickel equals 5 pennies

Finding the Value of a Coin Collection

- Design
  - Initial Algorithm
    1. Read in the count of nickels and pennies
    2. Compute the total value in cents
    3. Find the value in dollars and loose change
    4. Display the value in dollars and loose change

Finding the Value of a Coin Collection

- Design
  - Refined Algorithm
    1. Read in the count of nickels and pennies
    2. Compute the total value in cents
       1. `TotalCents` is 5 times `Nickels` plus `Pennies`
    3. Find the value in dollars and loose change
       1. `Dollars` is the integer quotient of `TotalCents` and 100
       2. `Change` is the integer remainder of `TotalCents` and 100
    4. Display the value in dollars and loose change

Finding the Value of a Coin Collection

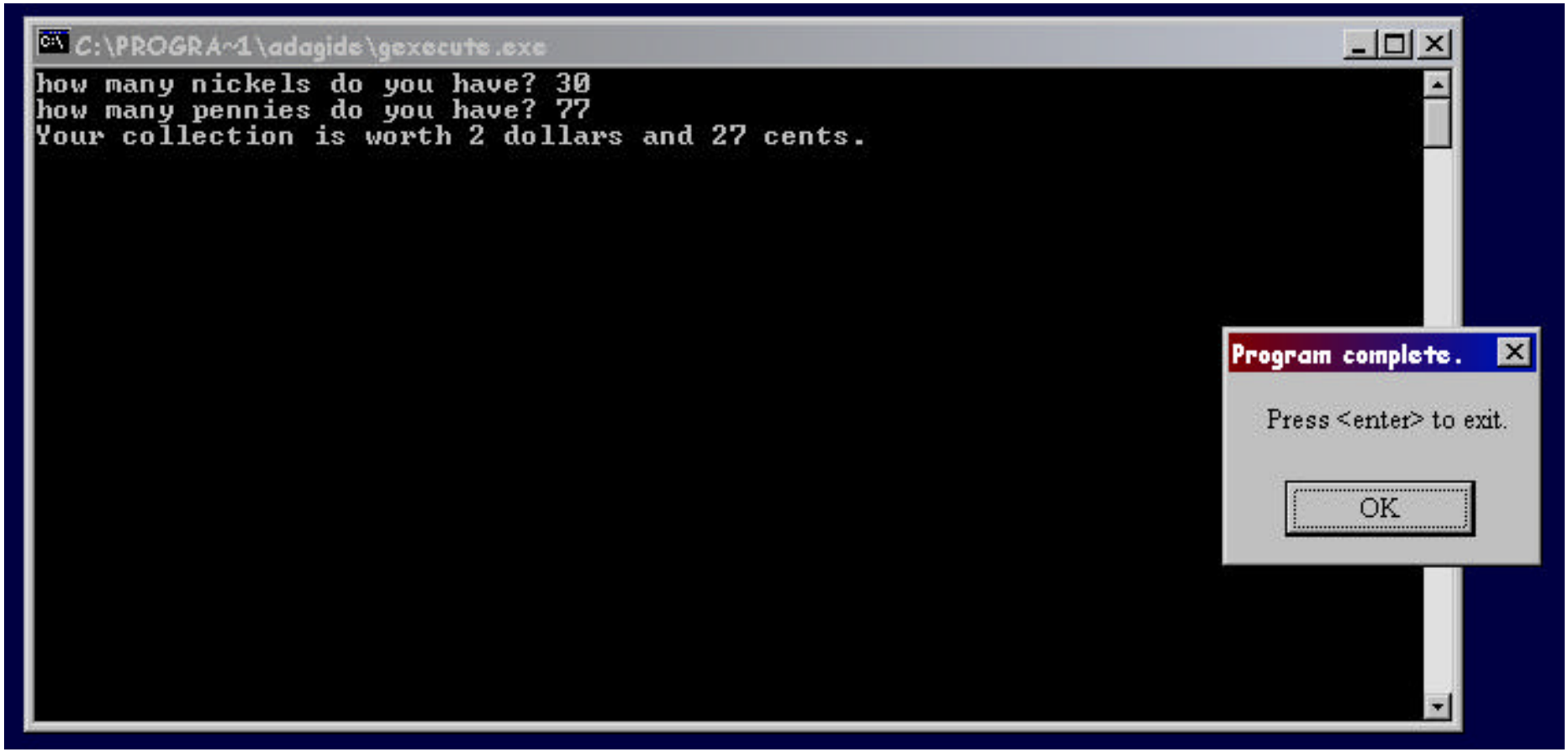
- Test Plan

Test case	Nickles	Pennies	Reason	Expected output
1	30	77	Typical	$2.27
2	0	59	No nickels	$0.59
3	13	0	No pennies	$0.65
4	13	-5	Negative	?
5	0	0	No coins	$0.00
6	qwerty	4	Bad input	?

Finding the Value of a Coin Collection

```
with Ada.Text_Io;
with Ada.Integer_text_Io;
procedure Coin_Collection is
   Pennies    : Natural; -- input, number of pennies
   Nickels    : Natural; -- input, number of nickels
   Dollars    : Natural; -- output, value in dollars
   Cents      : Natural; -- output, value in cents
   Totalcents : Natural;

begin -- coin_collection
   --prompt user for number of nickels and pennies
   Ada.Text_Io.Put (Item => "how many nickels do you have? ");
   Ada.Integer_Text_Io.Get (Item => Nickels);
   Ada.Text_Io.Put (Item => "how many pennies do you have? ");
   Ada.Integer_Text_Io.Get (Item => Pennies);

   Totalcents := 5 * Nickels + Pennies; -- compute total value in cents

   Dollars := Totalcents / 100; -- find value in dollars and change
   Cents := Totalcents rem 100;

   -- display the value in dollars and change
   Ada.Text_Io.Put (Item => "Your collection is worth ");
   Ada.Integer_Text_Io.Put (
      Item  => Dollars,
      Width => 1);
   Ada.Text_Io.Put (Item => " dollars and ");
   Ada.Integer_Text_Io.Put (
      Item  => Cents,
      Width => 1);
   Ada.Text_Io.Put (" cents.");
   Ada.Text_Io.New_Line;
end Coin_Collection;
```

Testing


C:\PROGRA~1\adagide\gexecute.exe
how many nickels do you have? 30
how many pennies do you have? 77
Your collection is worth 2 dollars and 27 cents.
Program complete.
Press <enter> to exit.
OK

Common Programming Errors

- Compilation errors, run-time errors (*exceptions* in Ada), and logic or algorithm errors.
- Compilation errors:
  - Distance_with_Errors
    - Finds distance traveled, given travel time and average speed

Distance_With_Errors

```
with Ada.Text_Io;
with Ada.Float_Text_Io;
procedure Distance_With_Errors is
   -- Finds distance, given travel time and average speed
   Howlong : Natural;
   Howfast : Float;
   Howfar  : Natural;

begin -- distance_with_errors
   -- prompt user for hours and average speed
   Ada.Text_Io.Put (Item => "How long will you be driving (integer) ? ");
   Ada.Float_Text_Io.Get (Item => Howlong);
   Ada.Text_Io.Put (Item => "At what speed (miles per hour, integer) ?");
   Ada.Float_Text_Io.Get (Item => Howfast);

   -- compute distance driven
   Howfast := Howlong * Howfar;

   -- display result
   Ada.Text_Io.Put (Item => " you will travel about ");
   Ada.Float_Text_Io.Put (Item => Howfar);
   Ada.Text-Io.Put (Item => " miles");
   Ada.Text_Io.New_Line;

end Distance_With_Errors;
```

Distance_With_Errors

```
GNAT 3.14p  (20010503) Copyright 1992-2001 Free Software Foundation, Inc.
Compiling: c:\gnat\lib\gcc-lib\pentiu~1\282a9d~1.1\adainc~1\howlong);.adb (source file time stamp: 2002-09-15 20:28:54)

 1. with Ada.Text_Io;
 2. with Ada.Float_Text_Io;
 3. procedure Distance_With_Errors is
 4.    -- Finds distance, given travel time and average speed
 5.    Howlong : Natural;
 6.    Howfast : Float;
 7.    Howfar  : Natural;
 9. begin -- distance_with_errors
10.    -- prompt user for hours and average speed
11.    Ada.Text_Io.Put (Item => "How long will you be driving (integer) ? ");
12.    Ada.Float_Text_Io.Get (Item => Howlong);
13.    Ada.Text_Io.Put (Item => "At what speed (miles per hour, integer) ?");
14.    Ada.Float_Text_Io.Get (Item => Howfast);
16.    -- compute distance driven
17.    Howfast := Howlong * Howfar;
19.    -- display result
20.    Ada.Text_Io.Put (Item => " you will travel about ");
21.    Ada.Float_Text_Io.Put (Item => Howfar);
22.    Ada.Text-Io.Put (Item => " miles");
                       |
   >>> missing ";“
23.    Ada.Text_Io.New_Line;
24.
25. end Distance_With_Errors;
25 lines: 1 error
```

Distance_With_Errors

```
1. with Ada.Text_Io;
2. with Ada.Float_Text_Io;
3. procedure Distance_With_Errors is
4.
5.    Howlong : Natural;
6.    Howfast : Float;
7.    Howfar  : Natural;
```

```
 9. begin -- distance_with_errors
10.    -- prompt user for hours and average speed
11.    Ada.Text_Io.Put (Item => "How long will you be driving (integer) ? ");
12.    Ada.Float_Text_Io.Get (Item => Howlong);
                              |
   >>> invalid parameter list in call
13.    Ada.Text_Io.Put (Item => "At what speed (miles per hour, integer) ?");
14.    Ada.Float_Text_Io.Get (Item => Howfast);
15.
16.    -- compute distance driven
17.    Howfast := Howlong * Howfar;
                             |
   >>> expected type "Standard.Float“
   >>> found type "Standard.Integer“
18.
19.    -- display result
20.    Ada.Text_Io.Put (Item => " you will travel about ");
21.    Ada.Float_Text_Io.Put (Item => Howfar);
                              |
   >>> invalid parameter list in call
   >>> possible missing instantiation of Text_IO.Integer_IO
22.    Ada.Text_Io.Put (Item => " miles");
23.    Ada.Text_Io.New_Line;
24.
25. end Distance_With_Errors;
25 lines: 5 errors
```

Finding the Value of a Coin Collection

- Exceptions (Run-Time Errors)
  - `How many nickels do you have? 13`
    `How many pennies do you have? -5`
    - CONSTRAINT ERROR
      - – Variables out of range in their programs
  - `How many nickels do you have? qwerty`
    - Ada.IO_EXCEPTIONS.DATA_ERROR
      - – Input/output exception

Control Structures

- So far: straight-line algorithms
- Control structures: `if`, `for`, `while`

```
if X >= 0.0 then
   Ada.Text_Io.Put (Item => "Positive");
else
   Ada.Text_Io.Put (Item => "Negative");
end if;
```

```
if X > 0.0 then
   Posprod = Posprod * X;
   Countpos = Countpos + 1;
end if;
```

For

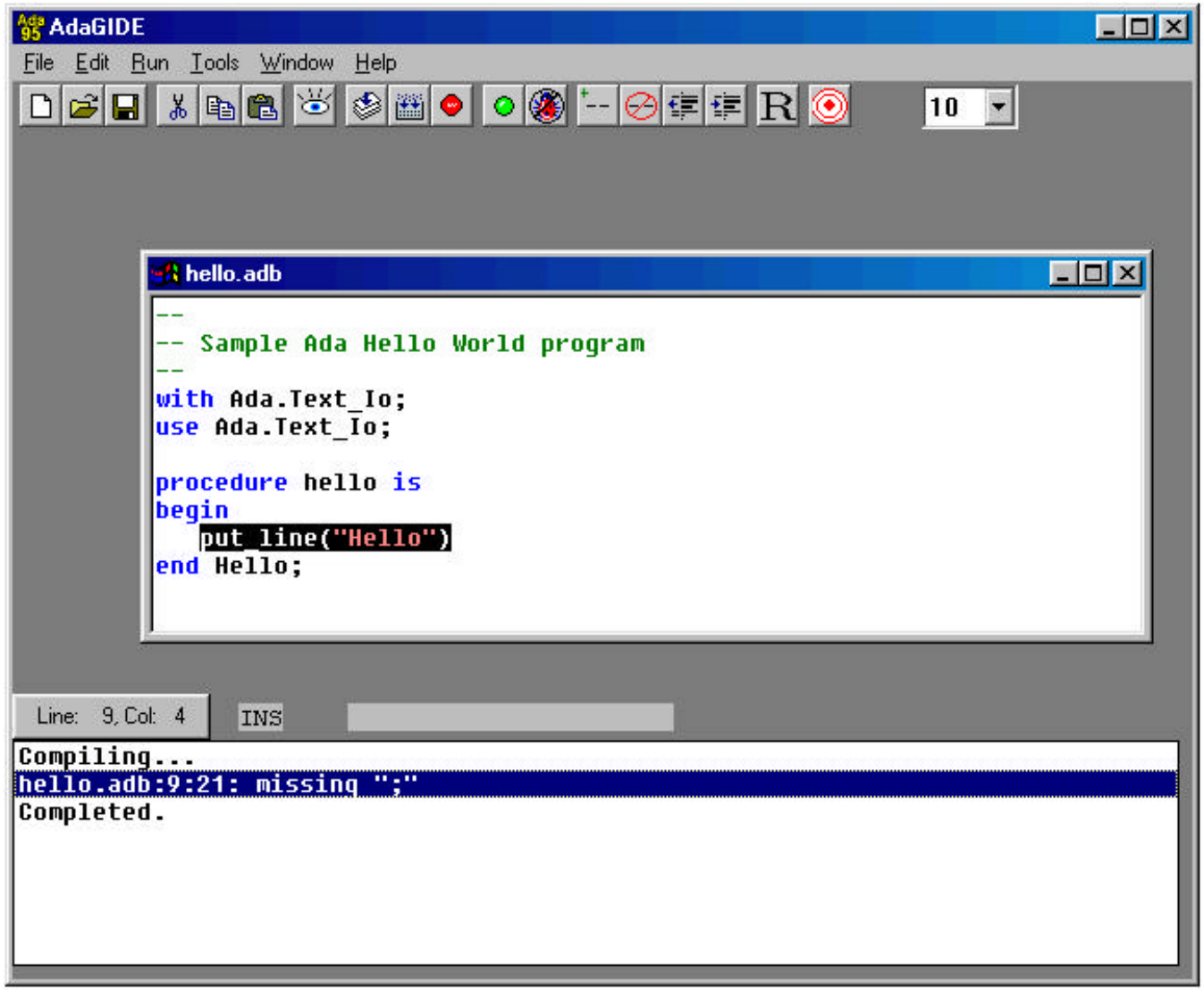
```
Ada.Text_Io.Put(Item => "Hello there. ");
Ada.Text_Io.Put(Item => "Hello there. ");
Ada.Text_Io.Put(Item => "Hello there. ");
Ada.Text_Io.Put(Item => "Hello there. ");
Ada.Text_Io.Put(Item => "Hello there. ");

--Can Be Written More Concisely As

for Count in 1..5 loop
   Ada.Text_Io.Put(Item => "Hello there. ");
end loop;


for Counter in Min .. Max loop
   Ada.Integer_Text_Io.Put (
      Item  => I,
      Width => 5);
   Ada.Text_Io.New_Line;
end loop;
```

While

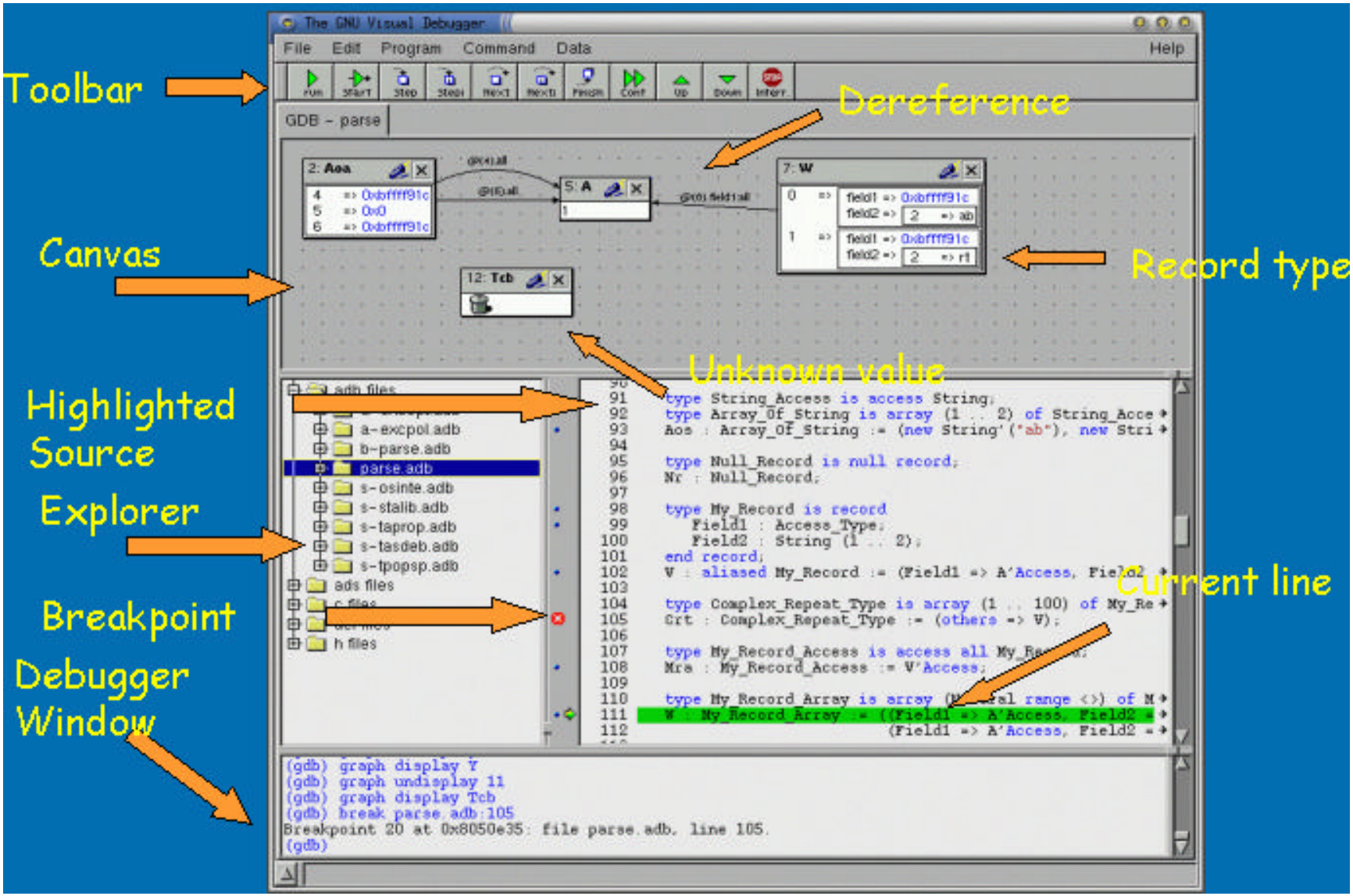
```
Power := 1;
while Power < 10000 loop
   Ada.Integer_Text_Io.Put (
      Item  => Power,
      Width => 5);
   Power = Power * 2;
end loop;
```

```
Power := 1;
loop
   exit when Power >= 10000;
   Ada.Integer_Text_Io.Put (
      Item  => Power,
      Width => 5);
   Power = Power * 2;
end loop;
```

AdaGIDE


AdaGIDE
File Edit Run Tools Window Help
10
hello.adb
--
-- Sample Ada Hello World program
--
with Ada.Text_Io;
use Ada.Text_Io;
procedure hello is
begin
put line("Hello")
end Hello;
Line: 9, Col: 4
INS
Compiling...
hello.adb:9:21: missing ";"
Completed.

The GNU Visual Debugger



- Problem set 1 due 9/25/02, 3pm
- Email addresses:
  - 16.35-students@mit.edu
  - 16.35-staff@mit.edu
- http://web.mit.edu/16.35/www
  - Class project
    - X-38 Integrated Test Plan
    - X-38 Software Development Plan
    - Early Flight Control System - Statement of Work
    - Software Development Plan
    - Software Test Plan

Project Groups

- Mandic,Milan
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